

Langley's DEVELOP Team Applies NASA's Earth Observations to Address Environmental Issues Across the Country and Around the Globe

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Introduction

The DEVELOP National Program was established over a decade ago to provide students with experience in the practical application of NASA Earth Science research results. As part of NASA's Applied Sciences Program, DEVELOP focuses on bridging the gap between NASA technology and the public through projects that innovatively use NASA Earth science resources to address environmental issues. Cultivating a diverse and dynamic group of students and young professionals, the program conducts applied science research projects during three terms each year (spring, summer, and fall) that focus on topics ranging from water resource management to natural disasters.

Headquartered at Langley Research Center (LaRC), DEVELOP has grown from a small team of three students in 1998 to a national program providing over 200 internship opportunities each year. There are currently nine DEVELOP offices: Six offices are located at NASA centers—Ames Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory, Langley Research Center, Marshall Space Flight Center, and Stennis Space Center—and three are regional offices—Mobile County Health Department (Alabama), Wise County Clerk of Court's Office (Virginia), and the Great Lakes and St. Lawrence Cities Initiative (Illinois)¹. DEVELOP teams conduct projects, under the guidance of science advisors from NASA and partner organizations that address national priorities and local environmental concerns, utilize NASA Earth observations, and provide end users with tools for enhanced decision making. In association with regional, national, and global partners, research is conducted to identify the widest array of practical uses for NASA data to help communities better understand environmental change over time.



DEVELOP students and staff with NASA Administrator **Charles Bolden** [front row center] at the 49th Robert H. Goddard Memorial Symposium on March 30th in Greenbelt, MD.
Photo credit: Pat Izzo.

DEVELOP Activities at Langley

LaRC also hosts the largest number of DEVELOP students each year. Aligning with LaRC's core competency in atmospheric science, multiple projects have been conducted, focusing on air quality monitoring in the U.S. and around the world. LaRC DEVELOP students have also worked on numerous projects dealing with sea-level rise and storm surge along the Eastern Seaboard, including the Hampton Roads area, where LaRC is located.

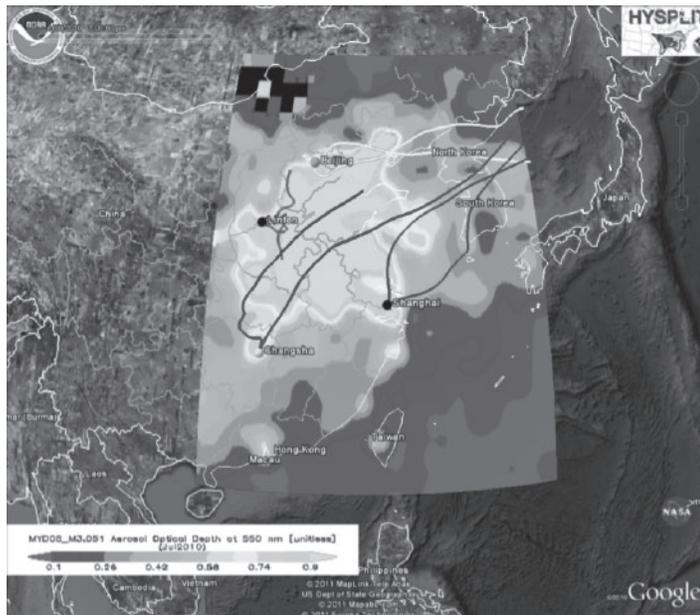
¹ *The Earth Observer* has done a series of articles on DEVELOP: March–April 2010 [Volume 22, Issue 2, pp. 7-9]; May–June 2010 [Volume 22, Issue 3, pp. 11-13]; July–August 2010 [Volume 22, Issue 4, pp. 10-12]; September–October 2010 [Volume 22, Issue 5, pp. 10-12]; November–December 2010 [Volume 22, Issue 6, pp.14-19]; January–February 2011 [Volume 23, Issue 1, pp. 4-7]; and March–April 2011 [Volume 23, Issue 1, pp. 22-25].

Air Quality Research

Since DEVELOP's inception, the LaRC DEVELOP team has conducted over a dozen different projects focused on enhanced monitoring of air quality on both local and regional scales. This research was done under the guidance of NASA atmospheric scientists at LaRC and has allowed students to learn not only about NASA's contributions to monitoring air quality through use of space-based remote sensing—such as the Moderate Resolution Imaging Spectroradiometer (MODIS) on Terra and Aqua, the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) mission, and the Ozone Measuring Instrument (OMI) on Aura—but also airborne missions like the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites - California Air Resources Board (ARCTAS-CARB). Two recent DEVELOP Air Quality projects based out of LaRC are described below.

China Health: Monitoring aerosol changes over Eastern China using NASA Earth observations

This project took place during the Spring 2011 term, and concentrated on the evaluation of different monitoring methods of aerosol optical depth (AOD) in Linfen, China, to assist in improving air quality management. Eastern China is home to a population of approximately one billion people, concentrated in large metropolitan areas; coal provides the majority of the region's energy. Due to the large amount of aerosol emissions related to coal burning, air quality is a major concern in many cities including Linfen, the capital of the Shanxi Province. Students investigated capabilities of Aqua MODIS images and CALIPSO lidar [Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP)] data to monitor aerosols. They also used NOAA's Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPPLIT) model to create trajectories of potential aerosol movement.



Aqua MODIS Aerosol Optical Depth (AOD) measurements and HYSPLIT trajectories displayed in *Google Earth* provide enhanced air quality monitoring and projected aerosol movement.

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Despite numerous well-documented negative effects on human health, China currently has no ambient air quality standards for PM_{2.5} i.e., particulate matter with particle diameter of 2.5 μm or smaller. This DEVELOP project therefore has the potential to benefit China and organizations attempting to monitor air quality within the country.

"I learned a great deal about the capabilities and limitations of satellite remote sensing in regard to measuring air quality levels. It was a good learning experience on how to conduct a research project, lead a research team, and work with students from different disciplines than my own," said **MyNgoc Nguyen** [LaRC DEVELOP/Old Dominion University—*Student & Project Co-Lead*]. "With only ten weeks to conduct the project, the team experienced the true meaning of both teamwork and flexibility."

California Natural Disasters: Using remote sensing data to assist management at Angeles National Forest

This project took place during the Summer 2010 term and sought to investigate degraded air quality levels stemming from the Angeles National Forest wildfires during the summer of 2009, as well as smoke plume trajectory modeling and associated health risks. The team utilized Terra's Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) and MODIS instruments, and data from the Environmental

Protection Agency's (EPA) *AirNow* system, the CARB's Air Quality and Meteorological Information System (AQMIS), as well as from ARCTAS CARB flights to observe air quality factors such as $PM_{2.5}$ levels, AOD, trace gases, and UV aerosol indices. The results obtained from this study demonstrated the feasibility and applications of NASA satellites and airborne missions for enhanced decision support to the projects partners: the U.S. Forest Service at Angeles National Forest and the South Coast Air Quality Management District. Students also investigated all aspects of the disastrous fire including fuel loading, burn extent, and impacts to public health.

Malcom Jones [LaRC DEVELOP/Christopher Newport University—*Student & Project Lead*] reported that: "using a suite of NASA's sensors to look at different aspects of the Angeles National Forest fire was extremely fascinating. Even though I am a computer engineering major, being able to work with other students and scientists in areas concerning air quality and ecological forecasting allowed me to see how I can apply my knowledge to a wide array of problems in the real world."

Sea Level Rise & Storm Surge Studies

LaRC's coastal location on the Eastern Seaboard makes sea level rise and storm surge inundation an important topic. LaRC suffered major damage from Hurricane Isabel in 2003. In response, NASA's Climate Adaptation Science Investigation (CASI) team tasked the center with investigating the effects that projected climate change could have on the center and what type of adaptations could potentially help abate impacts. Two recent DEVELOP sea-level rise and storm-surge studies based out of LaRC are described below.

LaRC Climate Change and Adaptation: Strategies to counter predicted climate change effects on NASA Langley Research Center

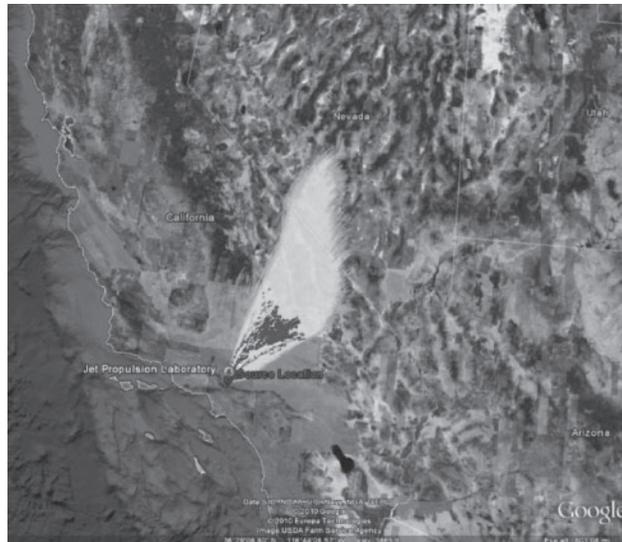
This project, taking place during the Summer and Fall 2010 terms, focused on improved storm-surge modeling and the related impact inundation could have on LaRC infrastructure, had practical application for the LaRC Science Directorate, as it allowed for improved forecasting and prioritization of assets for protection. Students gained experience with Geographic Information Systems (GIS), experience with the creation of multiple sea level rise scenarios, and practice utilizing climate models. The group was able to understand the impact storm-surge and sea-level rise could potentially have on the very buildings they were working in, making their research of even higher interest and importance.

"Analyzing tropical cyclone data has allowed us to quickly evaluate the types of storms that have affected the study area," says **Nathaniel Makar**, "As a meteorology major, this project gives me great experience **applying what I have learned in school to real world situations.**" [LaRC DEVELOP/Pennsylvania State University—*Student & Project Lead*].

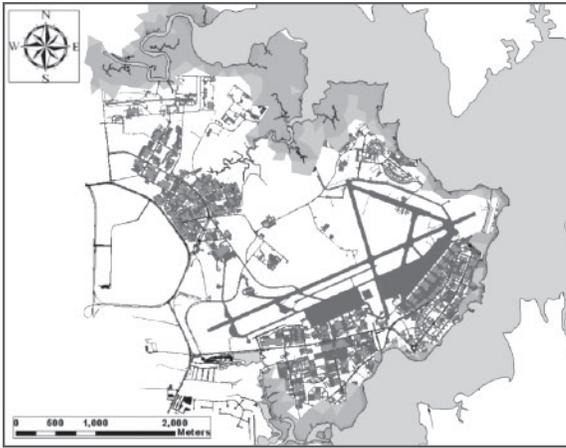
Outer Banks Climate: Assessing and establishing a process for understanding coastal changes in North Carolina

This project, also taking place during the Summer and Fall 2010 terms, investigated the use of NASA Earth Observing System (EOS) instruments, such as Jason-1, TOPEX/

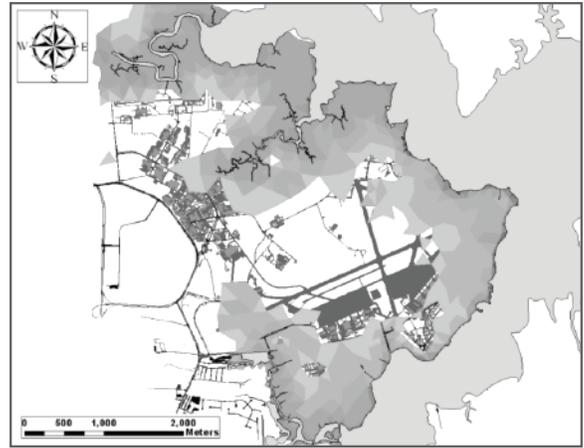
Output from the HYSPLIT Dispersion model for August 29, 2009 in *Google Earth* shows the smoke plume from the fires in Angeles National Forest spreading over the surrounding area.



Langley DEVELOP student **Malcom Jones** presents the Summer 2010 California Air Quality project poster at the American Geophysical Union (AGU) Fall 2010 Meeting in San Francisco, CA.



[*Left*] Hurricane Isabel storm surge inundation at LaRC and infrastructure at risk. [*Right*] Projected sea level rise of 100 cm (year 2070–2080) receiving a storm surge inundation similar to Hurricane Isabel levels at LaRC.



Poseidon, Landsat 5's Thematic Mapper (TM), and Terra's ASTER, to monitor North Carolina's dynamic and ever-changing Outer Banks estuarine systems. Rising sea levels and tropical cyclonic events have caused erosion and shore loss, threatening entire coastal communities. The team partnered with the North Carolina Division of Coastal Management (NCDCCM) to conduct research focusing on estuarine shoreline issues, including development of shoreline identification techniques, quantification of development trends along the shoreline, shoreline movement trend analysis, and consideration of all the above within the overarching theme of sea level rise.

"The potential benefits of this investigation to our coastal program are numerous and far reaching. The implications of creating analytical procedures for remotely sensed data from NASA satellite platforms allows an exciting opportunity for North Carolina to better manage its estuarine shoreline and plan for and manage future development patterns in the context of sea level rise," said **Jeffrey D. Warren** [NCDCCM—*Coastal Hazards Specialist (Project Partner)*]. "We are also eager to continue this work into future DEVELOP sessions to build on what I feel is groundbreaking research directly applicable to our State's coastal management efforts."

Conclusion

As DEVELOP's summer term begins in early June this year, students at LaRC will continue to learn and expand their knowledge of NASA's EOS capabilities in relation to air quality and sea level rise monitoring, as well as the other six Applied Sciences national application areas. Chal-

lenged to creatively and innovatively apply NASA's satellite and airborne Earth observations to real-world issues, LaRC DEVELOP students are gaining tangible skills and knowledge that will help them in their future careers.

More information is available about the DEVELOP National Program at develop.larc.nasa.gov/. Information about NASA's Applied Sciences Program is available at: applied-sciences.nasa.gov/, and LaRC's Science Directorate at science.larc.nasa.gov/. ■



Langley DEVELOP's Summer 2010 Outer Banks Climate project team. [*Left to right*] **Dominique Norman, Conor Collins, Chelsea Burns, Derek Doddridge, and Kristin Morgan.**